EXPLORING THE INTEGRATED COST CONTROL MODELS USED IN THE CONSTRUCTION INDUSTRY

Adjei, K. O.[1], Aigbavboa, C. O.[2], Thwala, W. D.[3]

[1]*Department of Building Technology, Faculty of Built & Natural Environment, Kumasi Polytechnic, P. O. Box 854, Kumasi - Ghana*
[1,2,3] *Department of Construction Management and Quantity Surveying, University of Johannesburg, Johannesburg, South Africa*

ABSTRACT
Project cost control models bring about all the techniques used in developing construction cost, cash flow forecasting and cost control. The construction industry has been unfamiliar with its characteristics and properties.This study therefore exploresthe existing integrated cost control models used in the construction industry.The study was conducted through a literatureresearch. Three different integrated cost control models used for the construction industry were selected between the years 2001 and 2013. The data used in the report is mainly qualitative and it was based on content analysis.The findings show that all the models had cost control systems. The inputs of the models were bills of quantities, resources list, activities programme, work breakdown structure and estimates. The processes of the models were managing all the resources; materials, labour, equipment and overhead costs, monitoring, controlling, reporting, decision making, corrective actions, forecasting and deadlines. Lastly the outputs of the models were project loss or profit, post evaluation and historical data kept for future use.

Keywords: *cost control, model, construction industry, forecasting, systems*

1.0 INTRODUCTION
Cost controlpractice should be seen as an important management tool that is crucial to the survival of every construction company in Africa and beyond.Project cost control models bring about all the techniques used in developing construction cost, cash flow forecasting and cost control. The construction industry has been unfamiliar with its characteristics and properties.An understanding of the various types of cost control modelsare vital to enable managers to effectively prepare their cost control and the development of future forecasting techniques for effective project delivery (Skitmore and Marston, 2005).According to Cleland and Ireland (2002) cost control is the process of monitoring; evaluating and comparing planned result with actual results to determine the status of the project cost, schedule and technical performance objectives.

kofiwusugh@yahoo.com
Adjei, K. O.[1], Aigbavboa, C. O.[2], Thwala, W. D.[3] (2016) Exploring The Integrated Cost Control Models Usedin The Construction Industry In: Mojekwu,J.N., Nani G., Atepor, L., Oppong, R.A.., Adetunji,M.O., Ogunsumi, L., Tetteh, U.S., Awere E., Ocran, S.P., and Bamfo-Agyei, E. (Eds) Procs 5th Applied Research Conference in Africa. (ARCA) Conference, 25-27 August 2016, Cape Coast, Ghana. 611-620

When construction begins the budget which is a conversion from the estimate, isfixed and acts as the baseline for the contractor to control costs (Bahaudin, et al, 2012, Adjei et al, 2015). The responsibility of the contractor to the client isto carry out the works according to the specifications, cost and schedule. The contractor at this stage is faced with one of the most difficult task in construction management as this is the phase that potentially has thegreatest ability to increase the planned budgeted costs (Halpinand Woodhead, 1998). With maximum profit inmind, because the goals of any business cannot be achieved without profit, the contractor will have to turn to cost control for assistance.

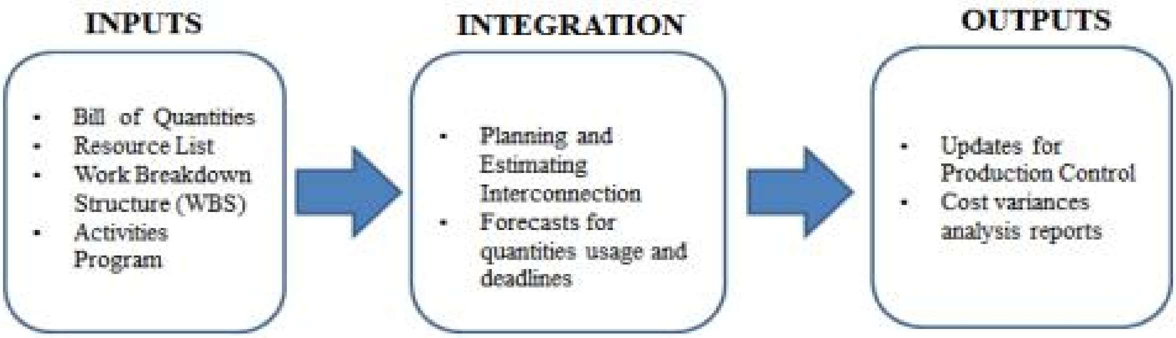
The cost control mechanismis intended to provide an early warning system, alerting of possible budget problems in good time for remedial action to be taken. The Quantity Surveyor or Cost Engineer may berequired to use the cost control process to develop a range of options for the design team toconsider and select one option within the prescribed budget limit (Dikko, 2002).

The objectives of the study were to compare and contrast the existing construction cost control models used in the construction industry.

PREVIOUS COST CONTROL MODELS

Figure 1: Cost Control Model

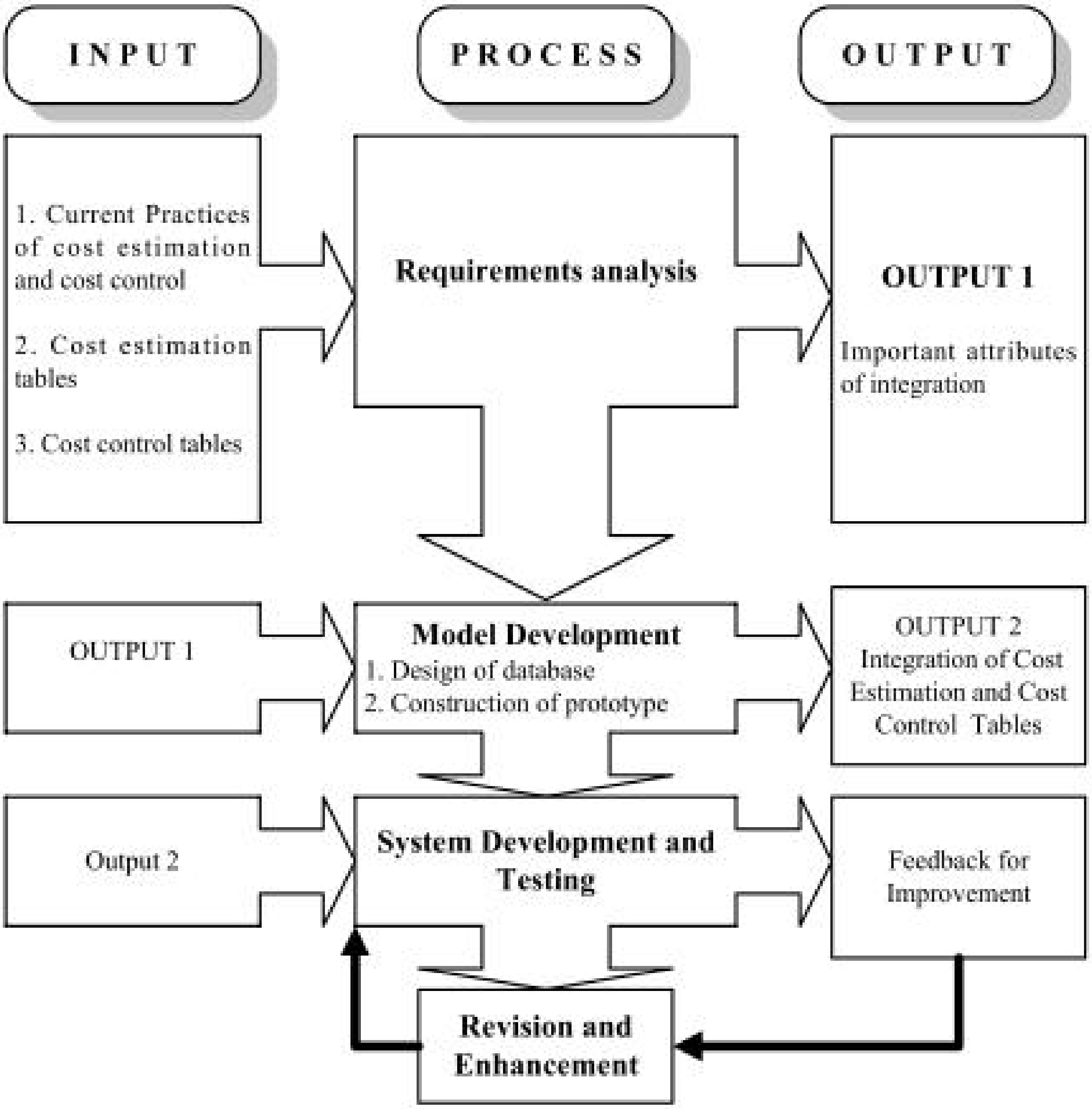
1



Source: (Amaral Lopes, 2013)

By implementing the aboveIntegrated System in figure 1, it is possible to obtain data regarding the current state of the project as well as its future, reliably, securely and quickly. Thus, any change in the resource cost or in its consumption to in any bill item, will be reflected dynamically in all of the reports and the documents that are available in the software package, and this information, if used correctly, will allow the project managers to make informed decisions whenever to improve the Project's final cost and completion date. This is true both when establishing the base forecast and at any stage during the execution phase of the Project (Amaral Lopes, 2013).

Figure 2: Cost Control Model 2



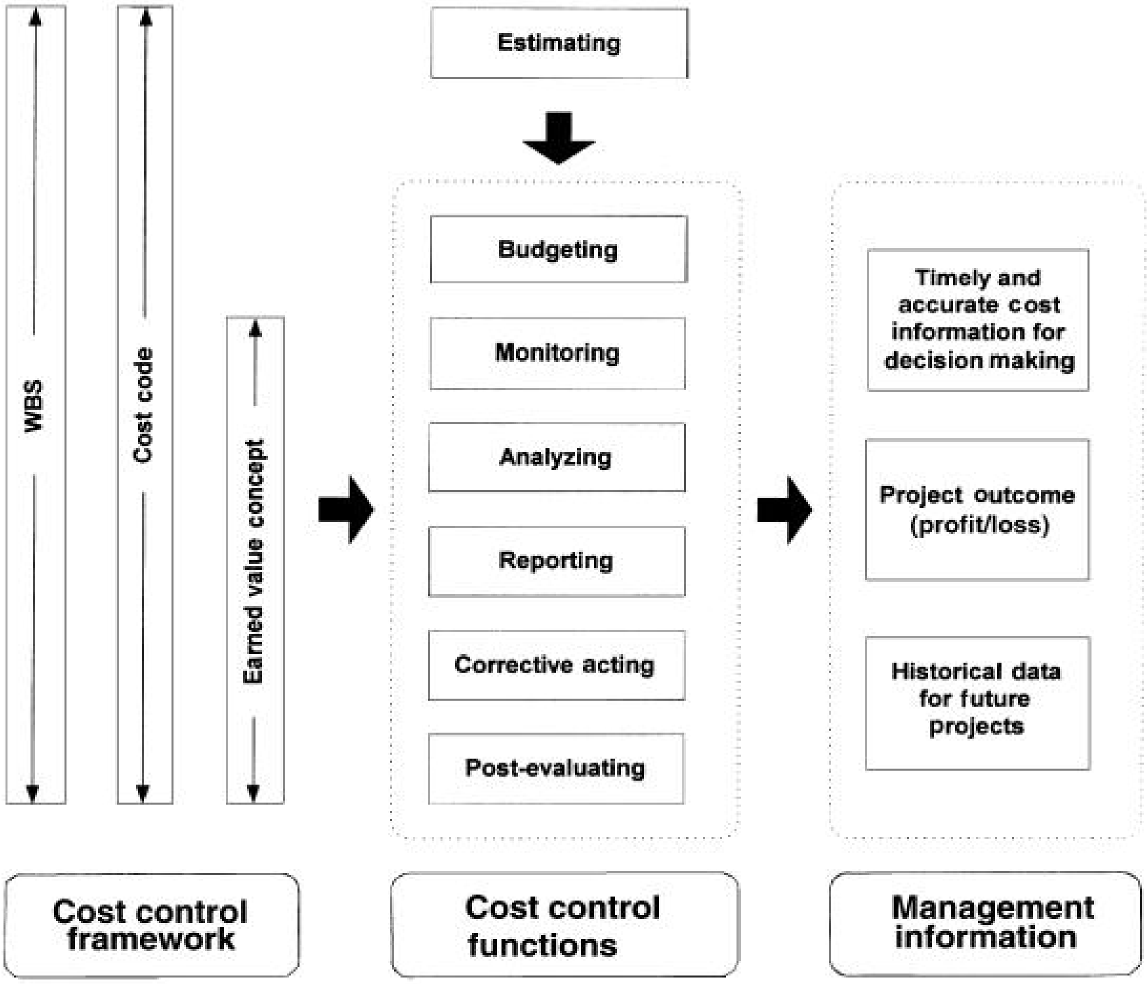
Source: (Azhar et al. 2003)

Cost engineering consists of cost estimation and cost control. Estimation is a methodology for forecasting and predicting cost and expenditures of a future project and to produce a budget (Azhar et al. 2003). His cost control model is based on the earned value concept, consisting of three elements: actual cost of work performed (ACWP), budgeted cost of work performed (BCWP) and budgeted cost of work scheduled (BCWS). ACWP for material = total amount paid for materials in a work package ACWP for labor = total amount paid to labor for a work package. ACWP for equipment = total amount paid for equipment assigned to a work package. BCWP for material, labor or equipment = percent work

kofiwusugh@yahoo.com

progress multiplied by total cost of labor or equipment or material in a work package. BCWS for material, labor or equipment = total estimated cost for labor, equipment, or material at the control time. On the basis of these parameters, cost variances and schedule variances are calculated todetermine work productivity which is used to measure the rate of work progress.

Figure 3: Cost control system: anintegrated view.



Source: (Charoenngam and Sriprasert, 2001)

Theframework, the cost control system above defined as a kind of information system that aims to provide management with timely and accurate cost information so that timely proper corrective actions can be taken. In addition, management information can be stored in a historical database and, in turn, serves as a feedback for future estimation. The system consists of three main parts, namely, cost control framework, cost control functions and management information(Charoenngam and Sriprasert, 2001).

Cost control framework

This part consists of three substantial factors, namely Work Breakdown Structure (WBS), Cost Code and Earned Value Concept. The essence of these factors has been widely discussed by many researchers (Rasdorfand budayyeh, 1991; Abu-Hijleh and Ibbs, 1993; Fleming andKoppelman, 1994; Giammalvo, 1994). It is well accepted that these factors must be appropriately employed as a critical frame for cost control system. With well-established framework, management can systematically manage the project in small manageable fashion and will not be overwhelmed by information explosion during construction phase. A pattern of proper cost control framework is illustrated in Fig. 4. Work breakdown structure: A task-oriented family tree of activities widely known as WBS is indispensable for project cost control. Unemployment or improper design of this structure can cause a chain of deficiencies in all cost control functions. Commencing with estimating and budgeting, work items may be duplicated, overlooked, or shelter inadequate details. This ineffective control reference, therefore, cannot be served as a guideline for systematic monitoring as well as comprehensive analysing. Finally, an evaluation of project outcome and establishment of historical cost data can also be ineffective. The following are two major criteria for assessment of WBS: Systematic structure The project must be partitioned into manageable elements of work for which budgets and expenditures can be systematically controlled. Formation of the WBS must begin by subdividing, or partitioning the project objective into successively smaller work elements until the lowest level to be reported on or controlled is reached(Charoenngam and Sriprasert, 2001).

Level of detail of WBS: The WBS should be sufficiently broken down into various types of level components including functional system (i.e. major work, activity, resource), and span of control (i.e. area, floor). If the WBS is brokendown into more than three levels and each work element has a value not exceeding 1 000 000 Baht (25 000 $US), the level of detail can be considered as 'adequate'(Charoenngam and Sriprasert, 2001).

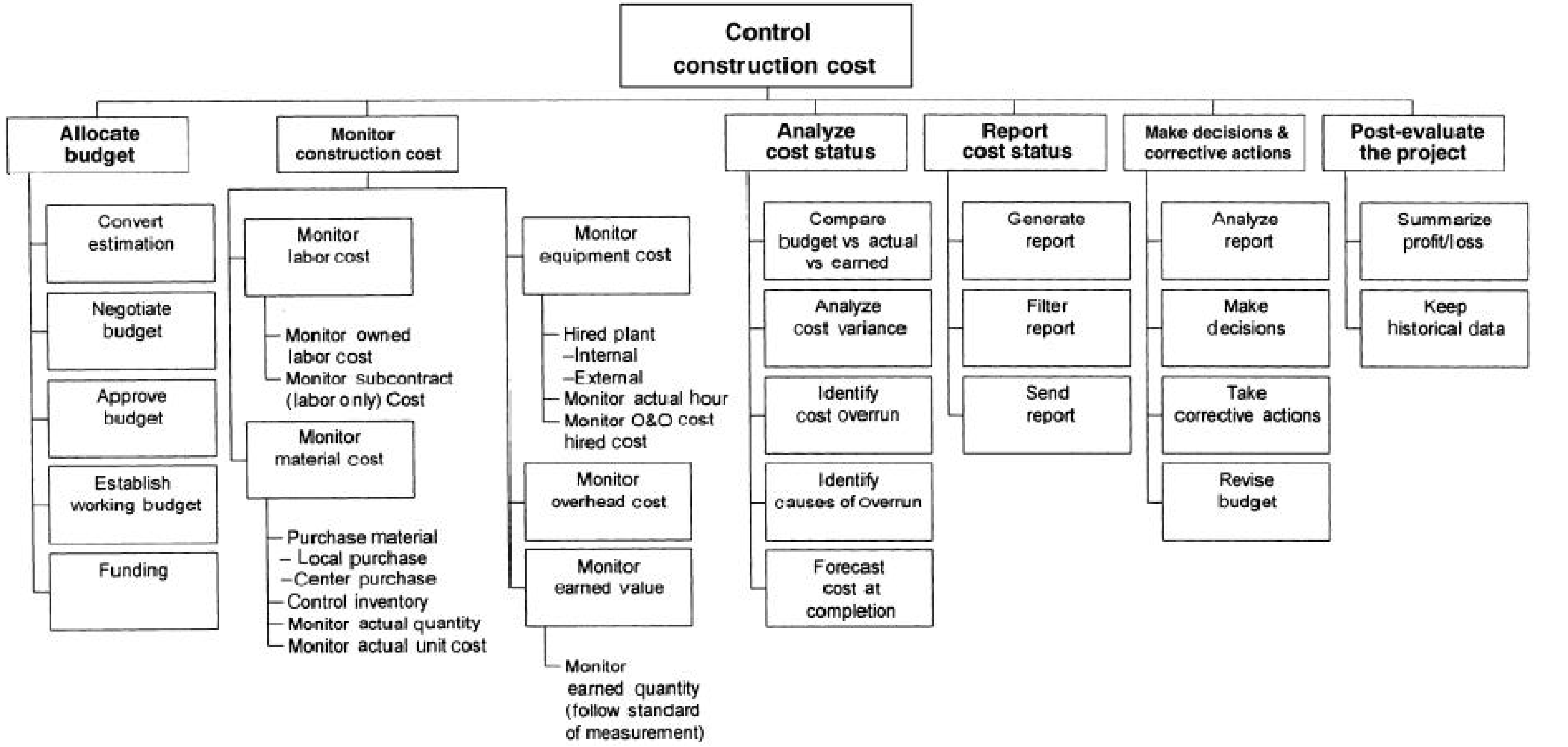
Cost code: The success of cost control system depends to a large extent on an ability to develop a sound system of identification coding for the basic cost data (Pilcher, 1994). Primarily, this cost coding system must be designed based upon a systematic cost item framework, so-called cost breakdown structure (CBS). Main essentialities for having the proper cost coding system were classically concluded. First, as a data-handling facility, vast amount of cost data can be organized, collected, manipulated and presented in a useful form (Ahuja, 1980). Economy of storage and rapidity in data retrieval can also be provided by computer (Pilcher, 1994). Secondly, as a common language, a standard set of cost codes should be publicized not only to the estimators, field supervisors and engineers, but also to the book-keepers and the management. These people who feed data and receive information relating to cost control have different backgrounds; left to themselves they will develop their own naming systems for work items, which will lead to complete chaos instead of cost control. In addition, cross-referencing of data files, drawings, bills of materials, requisitions, purchase orders and specifications can also be simplified (Ahuja, 1980). Being able to achieve all advantages summarized above, the code must be properly designed. The following are four major criteria for assessment of cost code.

Flexibility: The structure of cost code should have the ability to cope with future expanding items. Utilizing of one numerical-digit code can represent 10 items, i.e. 0, 1, 2,. . ., 9 while two numerical-digit code can represent up to a 100 items, i.e. 00, 01,. . ., 99. Apart from thenumerical code, an alphabetical code is another option. One alphabetical-digit code can represent up to 26 items, i.e. A, B, C,. . ., Z and each alphabet can be designed as a meaningful symbol, i.e. S-Structural work. When cost codes among the sampled cases are taken into account, three levels of the degree of flexibility can be labelled as (1) 'High' if the code at each level of CBS has two or more digits; (2) 'Medium' if the code has one digit in some levels and two digits in some levels; (3) 'Low' if the code at each level has only one digit(Charoenngam and Sriprasert, 2001).

Level of detail of CBS: Similar to the WBS, the CBS should be sufficiently broken down into various types of level components including functional system (i.e. major work, activity, resource), and span of control (i.e. area, floor). If the CBS is broken down into not less than three levels and each cost item has value not exceeding 1 000 000 Baht (25 000 $US), the level of detail can be considered as 'adequate'. Compliance with WBS: According to Rasdorf&Abudayyeh (1991), cost coding should be designed based on WBS. With one control frame, it facilitates data collection and enables identification of cost status in terms of activity progress(Charoenngam and Sriprasert, 2001).

Compliance with accounting code: When an accounting system is integrated within the cost control system, not only data processing can be substantially speeded up but also many frauds can be avoided. For instance, the account payable checking system can directly verify whether invoices of each work item are still under-budget and should be paid or not. Furthermore, account reports generated at head office and job cost reports generated at site can be cross-checked for ensuring accuracy(Charoenngam and Sriprasert, 2001).
The assessment of the control framework probably enables the author tosummarize effectiveness as well as deficiencies of eachaudited system. However, to acquire more confidence and a richer picture, assessment of each control function and management information has to betaken into account. Subjected to research constraints,efforts spent in this section did not try to cope with allexcessive detail in real practices, yet it valuably coversall critical aspects.
This part broke down into seven sub-sections consisting of one supported function – estimating – and sixfunctions for cost control – budgeting, monitoring,analysing, reporting, corrective action, and post-evaluating(Charoenngam and Sriprasert, 2001).

Figure 4: Cost control function breakdown structure.



Source: (Charoenngam and Sriprasert, 2001).

RESEARCH METHODS

The study was conducted through a literatureresearch. Three different integrated cost control models used for the construction industry were selected between the years 2001 and 2013. The papers were thenreviewed in line with the purpose of the study. The research method was divided into three stages:

1. Previous approach and initial search
2. Literature search
3. Summarizing the major contributions and in-depth study of the areas relating to cost control.

The data used in the report is mainly qualitative and it was based on content analysis.

FINDINGS AND DISCUSSION

All the three different integrated cost control models from Charoenngam and Sriprasert, (2001), Azhar et al., (2003) andAmaral Lopes (2013) had the basic techniques of construction cost control. All the models had a budget or cost prepared from the bills of quantities through estimation. Estimation is a methodology for forecasting and predicting cost and expenditures of a future project and to produce a budget (Azhar et al. 2003).Charoenngam and Sriprasert, (2001), added that the estimates must be finally established as a working budget. The work breakdown from the activities of the work can then be prepared. The WBS should be sufficiently broken down into various types of level components including functional system (i.e. major work, activity, resource), and span of control (i.e. area, floor)Charoenngam and Sriprasert, (2001).Formation of the WBS must begin by subdividing, or partitioning the project objective into successively smaller work elements until the lowest level to be reported on or controlled is reached(Charoenngam and Sriprasert, 2001).

The budget cost will then be compared to actual cost at site. It is normally based on the earned value concept, consisting of three elements: actual cost of work performed (ACWP), budgeted cost of work performed (BCWP) and budgeted cost of work scheduled (BCWS). ACWP for material = total amount paid for materials in a work package ACWP for labor = total amount paid to labor for a work package. ACWP for equipment = total amount paid for equipment assigned to a work package. BCWP for material, labor or equipment = percent work progress multiplied by total cost of labor or equipment or material in a work package. BCWS for material, labor or equipment = total estimated cost for labor, equipment, or material at the control time. On the basis of these parameters, cost variances and schedule variances are calculated to determine work productivity which is used to measure the rate of work progress (Azhar et al. 2003).

It agrees with Charoenngam and Sriprasert, (2001) where the model has sixfunctions of cost control – budgeting, monitoring,analysing, reporting, corrective action, and post-evaluating(Charoenngam and Sriprasert, 2001). Reports and documents are available in the

kofiwusugh@yahoo.com

software package, and this information, if used correctly, will allow the project managers to make informed decisions whenever to improve the Project's final cost and completion date (Amaral Lopes, 2013).Corrective measures are then taken and effective decision made to improve feedback of the cost control process. Post evaluation of the process is done to serve as a prototype for future similar projects.

CONCLUSIONS

All the three different integrated cost control models by Charoenngam and Sriprasert, (2001), Azhar et al., (2003) and Amaral Lopes (2013) had the basic techniques of construction cost control.

In summary, all the models have cost control systems. The inputs are bills of quantities, resources list, activities programme, workbreakdown structure and estimates. The process are managing all the resources – materials, labour, equipment and overhead costs, monitoring, controlling, reporting, decision making, corrective actions, forecasting and deadlines. The outputs are project loss or profit, post evaluation and historical data kept for future use.

It is however recommended that addition of management structures that would help effective cost control to the models.

REFERENCES

Abu-Hijleh, S. F. and Ibbs, C. W. (1993) Systematic Automated Management Exception Reporting, Journal of Construction Engineering and Management, 119, pp. 87-10

Adjei, K. O., Aigbavboa, C. and Thwala, W. D.(2015) Contractors Management Team Roles For Project Cost Control In Ghana In: Mojekwu, J. N., Nani G., Atepor, L., Thwala,W. D., Ogunsumi, L., Awere E., Ocran,S. P., and Bamfo-Agyei, E. (Eds) Procs 4th Applied Research Conference in Africa (ARCA) Conference, 27-29 August 2015, Ibadan, Nigeria.

Ahuja, H. N. (1980) Successful Construction Cost Control, John Wiley & Sons Inc., New York.

Amaral Lopes, P. A. (2013), Integration of the Construction Estimates in Construction ProgrammeMaster's Degree Thesis in Civil Engineering, TecnicoLisboa

Azhar, S., Ahmed, S.M. and Caballero, A. A. (2001) "Development of an Integrated Cost Estimation and Cost Control System for Construction Projects", Florida International University, pp 1-6

Bahaudin, A.Y., Elias, E.M., Dahalan, H. and Jamaluddin, R. (2012) Construction Cost Control: A Review of Practices in Malaysia, The 3rd International Conference on Technology and Operations Management "Sustaining Competitiveness through Green Technology Management" Bandung – Indonesia, July 4-6, 2012.

Charoenngam, C. and Sripraset, E., (2001), Assessment of Cost Control Systems: A Case Study of Thai Construction Organisations, Journal of Engineering Construction and Architectural Management, Vol.8, Issue 5-6, pp. 368-380

Cleland D. I. and Ireland R. L. (2002), Project Management (Strategic Design and Implementation. 4th Edition, McGraw-Hill, Inc.

Dikko, H.A. (2002), “Cost Control Models for Housing and Infrastructure Development”, FIG XXII International Congress Washington, D.C. USA, April 19-26 2002, pp. 5-9

Fleming, Q. W. andKoppelman, J. M.(1994) The Essence of Evolution of Earned Value, Cost Engineering, 36, pp. 21-27.

Giammalvo, P. D. (1994) Construction Specifications Institute's Masterformat: A Tool For Total Cost Management, Cost Engineering, 36, pp. 11-17.

Halpin, D. W. and Woodhead R. W. (1998), Construction Management, Second Edition, John Wiley & Sons Inc. New York.

Pilcher, R. (1994) Project Cost Control in Construction. Blackwell Scientific Publications, Oxford.

Rasdorf, W. J. and Abudayyeh, O. Y. (1991) Cost And Schedule Control Integration: Issues And Needs. Journal of Construction Engineering and Management, 117, pp. 486-501.

Skitmore, R. M., and Marston, V. K. (2005). Cost Modelling, E & FN Spon: Taylor & Francis Group, e-Library.

kofiwusugh@yahoo.com